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apparent at high rotational speeds, leading to a lower efficiency of the bearing as such, and consequently of the machine as a whole.

Especially in the case of high-speed motors, which are very compact, said phenomenon occurs, as the heat resulting from the mechanical and electric losses in the motor shaft can only be dissipated via a limited surface.

Another disadvantage of the bearings being warmed up, is that the bearing cage must usually be made of a special material which resists high temperatures, which is expensive.

When ball bearings with an angular contact are used, the problem of the bearing losses is further increased as a result of the pumping operation of this type of bearing.

→ 3A

~~From US 6,579,078 is known a centrifugal compressor which~~ is driven by a high-speed motor and which is bearing-mounted in a housing, whereby the lubricating oil of the slide bearings also serves to cool the bearings.

The basic idea of US 6,579,078 is to direct cooled oil through the slide bearings in order to cool and lubricate the bearings and to moreover use the excessive oil going through the bearing to flow onto the shaft and to thus cool the latter.

The excessive lubrication of the bearings leads to additional stilling losses, and the cooling oil is ~~moreover heated in this bearing, as a result of which the~~

-3A-

GB 595.346 describes a machine in the form of a turbine or a compressor, which is provided with a bearing which is lubricated by means of an oil mist. Further said GB 595.346 describes the presence of a separate cooling circuit which uses air or gas to cool the shaft of the machine.

A disadvantage of such known machines is that they are complex and require completely seperate circuits for cooling the shaft and lubricating the bearing. Also, the air or gas cooling will be insufficient for cooling the shaft and for realizing a proper functioning and a long life of the machine.

→ 3B

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Another disadvantage of the bearings being warmed up, is that the bearing cage must usually be made of a special material which resists high temperatures, which is expensive.

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→ 4

shaft, which is irrigated by said oil, will be cooled less efficiently.

However, these additional cooling methods are not efficient and require additional measures, in this case in the form of compressed air injection, in order to avoid that oil ends up in the space between the rotor and the stator. The present invention aims to remedy one or several of the above-mentioned and other disadvantages:

To this end, the invention concerns a machine with an improved bearing lubrication, which machine mainly consists of a housing and of a rotor provided on a shaft which is provided in the above-mentioned housing in a rotatable manner by means of oil-lubricated bearings, whereby lubrication ducts are provided in the housing to supply and discharge oil to and from the bearings, and whereby it is provided with cooling channels to supply and discharge a cooling agent, which cooling channels open opposite to the shaft, in a place between the rotor and the above-mentioned bearing and whereby the above-mentioned cooling channels are connected to the above-mentioned lubrication ducts.

An advantage of the invention is that no excessive amount of oil must be sent to the bearings in order to cool the bearings, as a result of which this amount of oil can be optimized for sufficient lubricating film to be built up, such that the bearing losses are strongly reduced.

Another advantage is that, thanks to the direct injection of a cooling agent on the shaft, the heat flow of the rotor to the bearing is interrupted, as a result of

which a reduced heat flow flows to the bearing and as a result of which also the life of the bearing is extended, since the viscosity of the oil is not affected by the temperature of the bearing.

An additional advantage of the lower temperature of the bearing is that a standard bearing cage can be used for the bearings, as a result of which the cost price of the bearings can be lowered.

→ 6A

~~According to a preferred characteristic of the invention~~ the rotor shaft is provided, opposite to the cooling channels, with one or several grooves.

This offers the major advantage that the contact surface between the cooling agent and the shaft increases, which considerably improves the cooling of the shaft.

In a preferred embodiment, the above-mentioned cooling channels extend through a gasket, which is provided with sealing lips directed towards the shaft on both sides of the above-mentioned grooves.

An advantage thereof is that no additional measures must be taken to prevent oil from entering between the rotor and the stator.

In a practical embodiment of a machine with an improved bearing lubrication according to the invention, the above-mentioned cooling channels are connected to the above-mentioned lubrication ducts, such that the lubricating ~~oil also serves as a cooling agent for the shaft~~.

Still another advantage of such a machine according to the invention is that the lubricating oil also serves as a cooling agent for the shaft, which allows to make the construction of the machine compact, relatively cheap and simple as it does not require the presence of separate circuits.

→ 5B

~~which a reduced heat flow flows to the bearing and as a~~ result of which also the life of the bearing is ~~extended~~, since the viscosity of the oil is not ~~affected~~ by the temperature of the bearing.

An additional advantage of the lower temperature of the bearing is that a standard bearing cage can be used for the bearings, as a result of which the cost price of the ~~bearings can be lowered~~.

According to a preferred characteristic of the invention, the rotor shaft is provided, opposite to the cooling channels, with one or several grooves.

This offers the major advantage that the contact surface between the cooling agent and the shaft increases, which considerably improves the cooling of the shaft.

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~~In a practical embodiment of a machine with an improved~~ bearing lubrication according to the ~~invention~~, the above-mentioned cooling channels ~~are~~ connected to the above-mentioned ~~lubrication~~ ducts, such that the lubricating ~~oil also serves as a cooling agent for the shaft~~.

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~~This offers the advantage that only one external hydraulic~~ circuit must be provided, ~~which~~ makes the construction as ~~a whole compact, relatively cheap and simple.~~

In the most preferred embodiment, a thermal barrier is also provided between the place where the cooling liquid is injected on the above-mentioned shaft and the bearing, whereby this thermal barrier consists of a material layer which is a bad heat conductor.

In this manner, the heat flow from the shaft to the bearings is minimized, and the life of the bearings is extended.

If the machine with improved bearing lubrication is an electric motor or generator, the cooling channels extend in the bearing cap which seals the housing, and the winding heads of the electric coils are cased in a heat-conducting material, for example a heat-conducting paste or epoxy or silicone, sprayed around the heads and which makes contact with the above-mentioned bearing cap.

By providing the bearing plate with a cooling, it is also possible to dissipate heat from the winding heads in the axial direction, which is essential for example in case of enclosed permanent magnetic motors.

In order to better explain the characteristics of the present invention, the following preferred embodiments of a machine with an improved bearing

In the bearing cap 4 are also provided lubrication ducts 14 and separate cooling channels 15, whereby each of the above-mentioned lubrication ducts 14 open via an opening 16 in the above-mentioned outer ring 13 of the spacer sleeve 11 and, opposite to the inner ring 12, in a space 17, which extends axially between the above-mentioned bearings 7 and which extends radially between the above-mentioned concentric rings 12 and 13 of the spacer sleeve 11.

Around the shaft 6 is provided a gasket 18, which is provided with a standing side wall 19 against the above-mentioned bearing cap 4 and which is provided with two sealing lips 20 directed towards the shaft 6, which are connected to the shaft 6 with a very small clearance and which are situated at a distance from each other.

In the above-mentioned gasket 18 are also provided channels 21, which open opposite to the shaft 6, between the above-mentioned sealing lips 20, and in a place between the rotor 5 and the above-mentioned bearings 7.

The above-mentioned cooling channels 15 in the bearing cap 4 are connected onto the channels 21 of the gasket 18 and thus form a single continuous cooling channel 15-21.

Between the above-mentioned sealing lips 20 are provided grooves 22 in the shaft 6, opposite to the channels 21 of the gasket 18.

The above-mentioned cooling channels 21 are preferably directed tangentially onto the shaft 6, at their outlet at the shaft 6, according to the rotational direction of the shaft 6.

The above-mentioned lubrication ducts 14 are part of a conventional lubrication circuit 23, which is represented by means of a dashed line in the figure and which is provided with a reservoir 24 with lubricating oil and a hydraulic pump 25.

The above-mentioned cooling channels 15,21 are in this case part of a cooling circuit 26 which also comprises, apart from a hydraulic pump 25 and a reservoir 24, a cooling device 27.

In the bearing cap 4 is provided a channel 28 at the bottom, which is connected to the inner space of the housing 2.

The working of such a motor 1 with an improved bearing lubrication is very simple and as follows.

When the motor 1 is excited, the rotor 5 is being driven and the bearings 7 of the rotor shaft 6 are lubricated by means of the lubrication circuit 23, whereby the pump 25 draws in lubricating oil from the reservoir 24 and directs this via the lubrication ducts 14 and the space 17 between the bearings 7, towards the bearings 7.

The lubricating oil delivery can hereby be adjusted with

great precision, such that a lubricating film is built up to a desired degree.

When the pump 25 in the cooling circuit 26 is switched on, cooling oil is in this case drawn in from a reservoir 24 and injected via a cooling device 27 and the first cooling channel 15 21 onto the shaft 6, between the sealing lips 20.

The cooling oil is preferably injected according to the sense of rotation of the shaft 6.

The grooves 22 which are provided opposite to the cooling channels 21-15 in the shaft 6 make sure that the heat-exchanging surface between the shaft 6 and the cooling oil is enlarged, and that the heat transfer from the shaft 6 to the cooling oil is thus promoted.

Next, the heated cooling oil is carried back to the reservoir 24 via a second cooling channel 21 15.

Thanks to the small clearance between the shaft 6 and the sealing lips 20, only a very small amount of cooling oil will leak away to the inner space of the housing 2. The limited amount of cooling oil which leaks away to this space is discharged via the channel 28 in the bearing cap 4.

Since the lubricating oil only serves to lubricate and not to cool the bearings 7, the delivery of the lubricating oil can be restricted, such that the bearing losses are strongly reduced and the temperature in the

Claims.

1.- Machine with an improved bearing lubrication, which machine mainly consists of a housing (2) and a rotor (5) which is provided on a shaft (6), provided in a rotatable manner in the above-mentioned housing (2) by means of oil-lubricated bearings (7), whereby, inside the housing (2), lubrication ducts (14) are provided to supply and discharge oil to and from the bearings (7), characterised in that it is provided with cooling channels (21,15) to supply and discharge a cooling agent, which cooling channels (21,15) open opposite to the shaft (6), in a place between the rotor (5) and an above-mentioned bearing (7) and in that the above-mentioned cooling channels (21,15) are connected to the above-mentioned lubrication ducts (14).

2.- Machine with an improved bearing lubrication according to claim 1, characterised in that the rotor (5) on the above-mentioned place opposite to the cooling channels (21,15) is provided with one or several grooves (22).

3.- Machine with an improved bearing lubrication according to claim 2, characterised in that the cooling channels (21,15) extend through a gasket (18), provided on both sides of the above-mentioned grooves (22) of sealing lips (20) directed towards the shaft (6).

4.- Machine with an improved bearing lubrication according to claim 3, characterised in that the clearance between the above-mentioned sealing lips (20) and the shaft (6) is very small.

5.- Machine with an improved bearing lubrication according to claim 3, characterised in that the above-mentioned cooling channels (21,15) open between the above-mentioned sealing lips (20).

6.- Machine with an improved bearing lubrication according to claim 5, characterised in that the above-mentioned cooling channels (21,15) are tangentially directed onto the shaft (6) at their outlet at the shaft (6).

7.- Machine with an improved bearing lubrication according to claim 6, characterised in that the cooling channels (21,15) are oriented such that they inject the cooling agent according to the sense of rotation of the shaft (6).

8.- Machine with an improved bearing lubrication according to claim 1, characterised in that the shaft (6) is provided with a thermal bridge (30) between the cooled part and the bearing.

9.- Machine with an improved bearing lubrication according to claim 8, characterised in that the shaft (6) is made of several parts, namely bearing-mounted parts (31) and non-bearing-mounted parts (32), whereby the

thermal bridge (30) is formed of a ring (33) made of a thermally insulating material, which is provided between the above-mentioned bearing-mounted and non-bearing-mounted parts (31 and 32).

10.- Machine with an improved bearing lubrication according to claim 8, characterised in that the thermal bridge (30) is formed of a bush (34) made of a thermally insulating material, which is provided between the shaft (6) and the bearing (7).

~~11.- Machine with an improved bearing lubrication~~ according to claim 1, ~~characterised in that~~ the above-mentioned ~~cooling channels~~ (21-15) are connected to the ~~above-mentioned lubrication ducts (14).~~

11 ~~12~~.- Machine with an improved bearing lubrication according to claim 1, characterised in that the lubrication ducts (14) and the cooling channels (21-15) are provided in a bearing cap (4) which is part of the housing (2).

12 ~~13~~.- Machine with an improved bearing lubrication according to claim 11 ~~12~~, characterised in that the above-mentioned bearing cap (4) is provided with a cooling.

13 ~~14~~.- Machine with an improved bearing lubrication according to claim 12 ~~13~~, characterised in that the lubrication ducts (14), the cooling channels (21-15) of the shaft (6) and the cooling channels (35) of the bearing cap (4) are connected to each other.

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~~15~~.- Machine with an improved bearing lubrication according to claim 11, ~~12~~, characterised in that, in case the machine is an electric motor (1) or generator, the winding heads (38) of the electric coils (37) are cased in a heat-conducting material (39) which makes contact with the above-mentioned bearing cap (4).